THE STUDY ON THE IMPACT OF CONSTANT POWER LOAD TO A DIRECT CURRENT POWER SYSTEM DRIVEN BY PHOTOVOLTAIC, WIND - THYRISTOR RECTIFIER AND LINEAR SOURCES

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Specially dedicated to my beloved parent, brothers and sisters for their love, dedication and sacrifice

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ABSTRACT

The phenomenon of instability is a major concern in DC power system. This phenomenon is contributed by the undesirable interaction between converter source-load as well as the behaviour of the power electronic loads which behave as a constant power load. This phenomenon occurs since each converter has its internal control function to regulate the output voltage. As a consequence, the converter tends to draw a constant power which produces negative incremental input impedance within its bandwidth, in which can lead the instability in the DC power system. The effect of constant power load to a DC power system driven by photovoltaic (PV), combination of wind and thyristor rectifier and also linear sources have been examined in this project. The effects of constant power load (CPL) to a DC power system was extensively reviewed and examined through simulation using MATLAB simulation software. The higher the power level of CPL used, more severe effects on the DC bus system is observed especially when it been driven by the wind energy sources. Simple compensation method using RC parallel passive damping network was proposed and the simulation on a DC power system driven by linear sources shows that the system managed to gain stability under steady state condition.

ABSTRAK

Fenomena ketidakstabilan voltan menjadi satu kebimbangan utama dalam sistem bekalan kuasa arus terus (AT). Gangguan yang tidak diingini ini boleh berlaku disebabkan tindakbalas di antara punca-beban sesebuah penukar dan juga disebabkan perilaku beban elektronik berkuasa malar. Fenomena ini berlaku kerana litar kawalan dalaman litar penukar cuba menetapkan voltan keluarannya. Akibatnya, litar penukar berkecenderungan untuk menghasilkan bekalan berkuasa malar, yang sifat galangan masukkannya adalah negatif menaik di dalam lingkungan jalur lebarnya yang boleh menyebabkan sistem bekalan kuasa arus terus (AT) menjadi tidak stabil. Projek ini mengkaji kesan penggunaan beban berkuasa malar terhadap sistem bekalan AT. Sumber kuasa yang digunakan ialah voltan photo (PV), kombinasi angin dan penerus thyristor dan juga sumber bekalan kuasa linear. Kesan penggunaan beban berkuasa malar terhadap sistem bekalan kuasa AT telah dikaji secara mendalam secara literasi dan juga melalui simulasi menggunakan perisian MATLAB. Keputusan yang diperolehi melalui penggunaan beban berkuasa malar sebesar 1000 W menunjukkan bahawa beban berkuasa malar terbukti menyebabkan ketidakstabilan sistem AT yang dipandu oleh tenaga angin, PV (di bawah keadaan fana) dan juga sumber linear. Kesan ketidakstabilan lebih buruk sekiranya sumber tenaga angin digunakan. Juga diperhatikan bahawa semakin tinggi nilai beban berkuasa malar, sistem menjadi lebih tidak stabil. Kaedah penstabilan mudah dengan menggunakan redaman pasif selari RC telah dicadangkan dan pelaksanaan melalui simulasi ke atas sistem bekalan kuasa AT dari sumber linear menunjukkan bahawa sistem berjaya mencapai keadaan stabil.

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LIST OF ABBREVIATIONS

DPS	-	Distributed Power System
CPL	-	Constant Power Load
DC	-	Direct current
PV	-	Photovoltaic
PVA	-	Photovoltaic Array
KCL	-	Kirchhoff's Current Law
KVL	-	Kirchhoff's Voltage Law
DFIG	-	Double-Fed Induction Generator

LIST OF SYMBOLS

R_L	-	CPL input resistance
R	-	Damping resistor
R_p	-	Parallel resistor
R_s	-	Series resistor
C_1	-	Filter capacitor
C_2	-	Damping capacitor
V_c	-	Capacitor voltage
V_s	-	Source voltage

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CHAPTER 1

INTRODUCTION

Whatever human does and practice have advantages and disadvantages. Same goes for the constant power load (CPL) phenomenon. Beside of it advantages such as reduce equipment size and weight and increase equipment efficiency it also can lead the DC power system to become unstable. This project was to study the impact of constant power load to a DC power system driving by photovoltaic (PV) and/ wind turbine. Therefore it is important to find simple solution if the constant power load proven to cause the DC power system become unstable. This report presents the CPL modelling, effects of CPL to a DC system, constant power load stabilisation method and simulation implementation as well as the analysis regarding the constant power load behaviour to a DC power system.

1.1 Problem Statement

Constant power load has became a major concern in DC power system due to its negative incremental input impedance characteristic which can lead the DC power system to instability. Therefore an effective stabilisation method must be derived to overcome this problem which can contribute in the development of green energy sources such as photovoltaic (PV) or wind turbine generator which use power electronic mean.

PV and wind turbine energy can become an alternative energy sources especially at rural area where the development of hydro power station to generate electricity consume large amount of land and cost. The development of PV and wind turbine energy sources will help in reducing our country dependent on non-renewable energy sources such as coal, oil, and gas to generate electricity. As already known the operating system of non-renewable energy sources have negative impacts such as global warming, carbon emissions to environment and also need high cost to produce the energy. Renewable energy sources such PV and wind turbine generator are environmentally friendly, fight global warming, bring less harm to the environment and reducing carbon emissions.

1.2 Project Objectives

The project was aimed to meet the following objectives:

1. To review CPL, PV and wind energy system, their modelling and characteristic.
2. To study the impact of CPL driven by DC power system (Linear supply, PV and wind - thyristor rectifier).
3. To simulate the effect of CPL to a DC power system.
4. To propose simple solution of reducing the negative impact of CPLs.

1.3 Project Scope

This project focuses on the review in detail the effects of constant power load in DC power system from previous studies.

1.4 Report Outline

Layout of the project report will tell the flow of the whole project and its contents. The content of each chapter was shown below:

Chapter 1 shows the introduction of the project which comprises of problem statement/hypothesis, project objectives and scope/limitation of the project. Problems that bring the idea to implement this project also stated in this chapter. This chapter also includes the main objectives and the scope of whole project.

Chapter 2 contains the theory of the whole project. It comprises the elements that need to be covered. The theories of the project are based from the references that will be used as guidance for the project.

Chapter 3 indicates the methodology to complete the project undertaken. Project methodology is about defining fundamental principles, rules and manners. It is a way to use all available techniques, tools and approaches used to achieve the predetermined objectives. It shows the flow of the project from the beginning and illustrates with the flow chart that review the important methods that should be considered before a project is carried out. It is important to demonstrate an awareness of methodological tools available and the understanding that is suitable for the project.

Chapter 4 explains the results, analyses and discussed of the project outcome. The impact of constant power load to a DC power system was shown in this part. This chapter contains analysis and discussion the plots obtained from the data collection from the simulation waveform. For the discussion part, it discussed the obstacles encountered when doing this project.

Chapter 6 shows the recommendation for the future work and conclusion. The recommendation includes the idea on how to improve this project for future work.

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